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by

Åsa Johansson

INSTITUTE FOR INTERNATIONAL ECONOMIC STUDIES
Stockholm University

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Institute for International Economic Studies
S-106 91 Stockholm
Sweden

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Abstract

This paper studies the interaction between time inconsistency problems in labor market policy and monetary policy. When both policies are discretionary, there is a positive inflation bias, whereas the bias in labor market programs may be either positive or negative. A commitment of labor market programs to zero increases inflation, as compared to the case when both labor market policy and monetary policy are discretionary. Delegation of labor market policy to a liberal labor market board may improve the discretionary outcome, even if labor market programs crowd out regular employment. A conservative central bank always reduces the social loss, even when monetary policy interacts with labor market policy.

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**Institute for International Economic Studies, Stockholm University, S-106 91 Stockholm, Sweden. E-mail: asa.johansson@iies.su.se

1 Introduction

In the last decade, Western Europe has experienced high and persistent rates of unemployment, which has increased the interest in active labor market policy as a means of reducing unemployment. This paper investigates how the time inconsistency problem of labor market policy can arise and how this can interact with the time inconsistency problem of monetary policy.

The time inconsistency problem of monetary policy has been thoroughly investigated. According to Barro and Gordon (1983), the time-consistent rate of inflation is higher than the rate to which the government can credibly commit. Similar time inconsistency problems can be associated with an active labor market policy, but have not been subject to any thorough analyses, which has been pointed out by Blanchflower, Jackman and Saint-Paul (1995), and Calmfors (1995).

Active labor market policy can be split into three different categories: (*i*) measures to increase labor demand; (*ii*) measures to increase labor supply; and (*iii*) measures to improve the matching process between vacancies and job searches. The overall effect of an active labor market policy is not, a priori, clear. Labor market policy may increase employment by increasing the competition for jobs and putting downward pressure on wages. It may also increase employment by moving workers from sectors with an excess supply of labor to sectors with an excess demand for labor. But labor market policy might also have adverse effects on employment. If participation in labor market programs seems more attractive than open unemployment, for instance due to a higher compensation level, then programs may cause upward pressure on wages and thus reduce regular employment. In Calmfors (1994), the effects of labor market programs are analyzed and the conclusion is that the aggregate effect cannot be determined from theoretical reasoning only.

Active labor market policy in Sweden has been subject to several empirical and theoretical evaluations, most of which are micro studies of its effects on individuals. The number of evaluations of effects on macroeconomics variables is lower (for an overview see Calmfors, Forslund and Hemström, 2001). One type of macroeconomic studies investigates the relation between wage setting and the size of active labor market programs, henceforth denoted ALMPs. The findings in the time-series studies tend to be that an expansion of ALMPs increases wage pressure and reduces employment (Calmfors, 1993). Skedinger (1995), and Calmfors and Skedinger (1995), find that job creation programs in Sweden have negative effects on regular employment, although several studies exploiting cross-country variations show that ALMPs result in strong reductions in open unemployment and, possibly, also in increases in regular employment (e.g. Layard et al., 1996; Zetterberg 1993; Scarpetta, 1996). If job creation and training are distinguished, training programs seem to have more favorable effects on employment than job-creation programs (Calmfors, 1994; Calmfors and Skedinger, 1995).

If ALMPs have adverse effects on employment, the government has an incentive to hold back their size in order not to increase the wage pressure. However, the announcement of low ALMPs may not be credible, for once wages have been set, the government can increase ALMPs to reduce open unemployment without risking wage increases. But, if the private sector understands the incentives of policymakers, policies will be anticipated and the wage will increase and the outcome may be discretionary with too high wages, too large ALMPs and too low employment. ALMPs then suffer from a time-inconsistency problem similar to the one of monetary policy, with which we are familiar.

If ALMPs have a wage-reducing effect, the discretionary equilibrium may instead involve too small ALMPs. Once wages have been determined, the government's incentive to stick to announced large ALMPs is weakened, because the budget cost of programs can be reduced, by cutting the size without affecting the wage contracts. Since this is recognized by the private sector, wages will not be held back and the economy then ends up in a situation with too small ALMPs, too high wages and too low regular employment.

The purpose of this paper is to formalize the time inconsistency problem for ALMPs and to study the interaction between the time inconsistency problems for monetary policy and active labor market policy. I shall also analyze delegation to independent agencies and commitment to simple rules for both monetary policy and labor market policy, when regarded as methods of solving the time-inconsistency problems. In the case of monetary policy, an example of such a simple rule would be to enter the European monetary union (EMU). In the case of labor market policy, a country could refrain from setting up the necessary institutional framework for such policies.

The paper is structured as follows. In section 2, the time inconsistency problem for both monetary policy and labor market policy is analyzed. Section 3 studies commitment to simple rules for money growth and ALMPs. Section 4 analyzes delegation of monetary policy and labor market policy to independent agencies. Section 5 concludes.

2 A model for the time-inconsistency problems of monetary policy and labor market policy

In this section, I set up a one-period model. Assume that the government's preferences are represented by the following quadratic loss function

$$L_t = \frac{1}{2}\left[\lambda_0 r_t^2 + \lambda_1 u_t^2 + \pi_t^2\right]. \tag{1}$$

r_t is the fraction of the labor force participating in ALMPs, u_t is the fraction that is openly unemployed and π_t is the inflation rate. λ_0 and λ_1 are positive weights on ALMPs and open unemployment. Open unemployment and inflation are standard arguments in the objective function in the monetary literature. The reason for including ALMPs is that increased ALMPs at a given rate of open unemployment imply lower regular employment, which is disliked by the government. The workers are likely to associate different levels of utility with open unemployment and ALMPs, and the two alternatives may cause the government different budget costs. Accordingly, I enter open unemployment and ALMPs as separate arguments in the loss function, rather than as a sum. In the loss function, the target values for ALMPs, open unemployment and inflation are set at zero. This is a normalization to simplify the model.

My unemployment equation can be derived from a simple model with a labor-demand relationship and a wage-setting equation. Labor demand follows from profit maximization of firms, which hire labor until the marginal product equals the real wage. With a constant labor-demand elasticity, employment can be written as a function of the real wage and a supply shock in the following way

$$\log n_t = \theta - \gamma\left(\log W_t - \log P_t\right) + \varepsilon_t. \tag{2}$$

n_t is the fraction of the labor force that is regularly employed, W_t is the nominal wage, P_t is the price level, γ is the constant labor demand elasticity, ε_t is a supply shock and θ is a positive constant.

Open unemployment is defined as

$$u_t = 1 - r_t - n_t. \tag{3}$$

Assume the following wage-setting equation

$$\log W_t - \log P_t^e = \beta_0 + \beta_1 r_t^e, \tag{4}$$

where P_t^e is the expected price level, r_t^e is the expected size of ALMPs and β_0 is a positive constant. The wage-setting equation can be considered as derived from a wage-bargaining model or an union wage-setting model. In these models, it can be shown that wages depend on the welfare of a laid-off worker. The value of this outside opportunity can be taken to depend on the size of ALMPs, because this size determines the probability of a laid-off worker participating in a program. One possible mechanism is that participation in ALMPs reduces the welfare loss of being unemployed, because the compensation in programs is higher than the unemployment benefit (Calmfors and Forslund, 1991). ALMPs may also generate other positive welfare effects for the unemployed, such as psychological well-being (Korpi, 1994). If so, larger ALMPs tend to improve the outside opportunity for the unemployed and thus increase the wage pressure. Another possibility is that participation in ALMPs is welfare-decreasing compared to open unemployment due to the reduction in leisure time. This assumes that participation in ALMPs is not voluntary but rather a way of making the willingness to work a condition for receiving unemployment benefits (Jackman, 1994). In this case, larger ALMPs should be expected to decrease the wage pressure. This may also occur if participation in ALMPs increases the competition for jobs, by preventing the unemployed from leaving the labor force. Depending on which effects are the strongest, β_1 may thus be positive or negative.

As wage contracts are concluded for a coming period, the private sector must form expectations about future ALMPs and the price level at the time when wages are set. Hence, the expected price level and the expected size of ALMPs enter as arguments in (4). To simplify, I assume away mobility between different sectors, i.e., the probability of finding a job in another sector if a worker is laid off is assumed to be zero, so that aggregate employment does not enter in (4). Unemployment compensation or compensation in ALMPs are regarded as constant in my analysis and accordingly, do not enter in (4) either.

Rewrite (4) as

$$\log W_t - \log P_t = \beta_0 + \beta_1 r_t^e - (\log P_t - \log P_t^e)\,,$$

and combine it with (2) to get

$$\log n_t = \theta - \gamma\beta_0 - \gamma\beta_1 r_t^e + \gamma\,(\log P_t - \log P_t^e) + \varepsilon_t.$$

Since

$$\log n_t = \log(1 - (r_t + u_t)) \approx -\,(r_t + u_t)\,,$$

I can write

$$u_t = \alpha_0 - \alpha_1 r_t^e - \gamma\left(p_t - p_t^e\right) - r_t - \varepsilon_t,$$

where $\alpha_0 = \gamma\beta_0 - \theta$ and $\alpha_1 = -\gamma\beta_1$. p_t and p_t^e denote logarithms of the price level and the expected price level. For the model to be useful, $0 < \alpha_0 < 1$ must hold. This means that the open unemployment rate must be between zero and one, if expectations are correct and there are no ALMPs and supply shocks. α_1 measures the effect of ALMPs on open unemployment. The sign of α_1 is unclear, since ALMPs may affect employment through mechanisms working in different directions, as discussed above. $\alpha_1 < 0$ means crowding-out effects on employment of ALMPs and $\alpha_1 > 0$ crowding-in effects. I shall assume that $\alpha_1 > -1$, since this is a consistent finding in the empirical studies (see e.g. Zetterberg, 1993; Calmfors and Skedinger, 1995; Forslund and Krueger, 1995; Skedinger, 1995; Layard, et al. 1996; Scarpetta, 1996). Crowding-out effects might naturally be associated with job-creation programs and crowding-in effects with training programs, as empirical studies tend to indicate that the former have negative and the latter positive effects on employment.[1]

Since $\pi_t - \pi_t^e = p_t - p_{t-1} - (p_t^e - p_{t-1}) = p_t - p_t^e$, I can rewrite open unemployment as

$$u_t = \alpha_0 - \alpha_1 r_t^e - \gamma\left(\pi_t - \pi_t^e\right) - r_t - \varepsilon_t, \tag{5}$$

where π_t^e is the expected inflation rate.

Assume that the government does not control inflation directly, but instead controls a policy instrument, that is, money growth, which affects inflation according to

$$\pi_t = m_t + v_t, \tag{6}$$

where m_t is money growth and v_t is a demand or "velocity" shock. Shocks ε_t and v_t are *i.i.d.*, with an expected value of zero and known variances of σ_ε^2 and σ_v^2. The government has private information about shocks ε_t and v_t, and it can observe the realization of the shocks before making any decisions, while the private sector does not have access to such information when setting the wages. This introduces a potential role for stabilization of shocks with monetary and labor market policy.

The private sector is assumed to have rational expectations over inflation and ALMP, i.e.,

$$\begin{aligned} \pi_t^e &= E_{t-1}\pi_t, \qquad (7)\\ r_t^e &= E_{t-1} r_t, \end{aligned}$$

[1] A possible explanation is that training programs are more effective than job-creation programs for increasing the skills of the unemployed and hence their competitiveness. Another explanation is that the compensation in job-creation programs is usually higher than the compensation in training programs.

where E_{t-1} denotes expectations conditional on information in period $t-1$. I use (6) to rewrite the rational expectation of inflation as

$$\pi_t^e = E_{t-1}(m_t + v_t) = m_t^e, \tag{8}$$

where m_t^e is the rational expected money growth.

I shall assume that monetary policy and ALMPs are determined at the same time, i.e., monetary policy can not be determined after having observed ALMPs, or vice versa. This assumption seems natural since both monetary policy and ALMPs can react to shocks with short lags. This is a standard assumption with respect to monetary policy. For Sweden, it has been shown that ALMPs are very flexible in response to cyclical conditions (Ohlsson, 1992, 1993).

2.1 Commitment

Precommitment to an optimal rule is unrealistic, since it is difficult to enforce. Still, the solution is here considered as a benchmark. The timing under commitment is thus: (**i**) the government announces rules for ALMPs and money growth before wages, employment, expectations of ALMPs and money growth are determined and shocks are revealed. This means that the government internalizes the effect of its policy decisions on private-sector expectations. (**ii**) The private sector sets wages and employment on basis of information in period $t-1$, without observing shocks ε_t and ν_t, i.e., private agents form expectations over r_t^e and m_t^e. (**iii**) The values of v_t and ε_t are observed by the government; (**iv**) money growth and ALMPs are simultaneously implemented according to the rules and (**v**) macroeconomic outcomes are realized.

The policy problem is viewed as a once-and-for-all choice of the rules before any private-sector decisions are made.

The government's minimization problem can be modelled as

$$\min_{r_t, r_t^e, m_t, m_t^e} E_{t-1}[L],$$
$$\begin{aligned} s.t\ u_t &= \alpha_0 - r_t - \alpha_1 r_t^e - \gamma(\pi_t - \pi_t^e) - \varepsilon_t, \\ \pi_t &= m_t + v_t, \\ r_t^e &= E_{t-1} r_t, \\ \pi_t^e &= E_{t-1}\pi_t, \end{aligned}$$

where E_{t-1} denotes that the policy rules must be chosen before the realization of the shocks are observed. The minimization is done as if the government could actually control private-sector expectations of ALMP and money growth as well as the actual size of programs and money growth, due to the fact that the choice of policy rules are made before the private-sector sets wages and thus forms expectations of π_t^e and r_t^e.

The Lagrangian for the problem under commitment is

$$\mathcal{L} = E_{t-1}\left\{\frac{1}{2}\left(\lambda_0 {r_t}^2 + \lambda_1 {u_t}^2 + \pi_t^2\right)\right\} - \theta_{1,t-1}\left(r_t^e - E_{t-1}r_t\right) - \theta_{2,t-1}\left(\pi_t^e - E_{t-1}\pi_t\right).$$

The first-order condition with respect to r_t is

$$\lambda_0 r_t - \lambda_1 u_t + \theta_{1,t-1} = 0, \tag{9}$$

and the first-order condition for r_t^e is

$$-\alpha_1 \lambda_1 E_{t-1} u_t - \theta_{1,t-1} = 0. \tag{10}$$

$\theta_{1,t-1}$ is the Lagrange multiplier associated with the constraint of rational expectations of ALMP. I can eliminate the multiplier $\theta_{1,t-1}$ by combining (9) and (10). This gives

$$\lambda_0 r_t - \lambda_1 u_t - \alpha_1 \lambda_1 E_{t-1} u_t = 0. \tag{11}$$

The first term in (11) is the direct cost of an increase in ALMPs and the second term is the marginal benefit of a reduction in open unemployment for given r_t^e. The third term is the marginal loss (benefit) of an increase (decrease) in open unemployment when r_t^e increases (depending on whether there are crowding-out or crowding-in effects of ALMPs).

The first-order condition for m_t is

$$-\gamma \lambda_1 u_t + \pi_t + \theta_{2,t-1} = 0, \tag{12}$$

and the first-order condition for m_t^e is

$$\gamma \lambda_1 E_{t-1} u_t - \theta_{2,t-1} = 0. \tag{13}$$

$\theta_{2,t-1}$ is the Lagrange multiplier associated with the constraint of rational expectations of money growth. Again, I can substitute for the multiplier, which gives

$$-\gamma \lambda_1 u_t + \pi_t + \gamma \lambda_1 E_{t-1} u_t = 0. \tag{14}$$

The first term in (14) is the marginal benefit of a decrease in open unemployment when inflation increases for given expectations. The second term is the direct cost of an increase in inflation, and the third term is the marginal cost of an increase in open unemployment when the expected inflation increases.

From (11) and (5), I get:

$$\lambda_0 r_t - \lambda_1 \alpha_0 + \lambda_1 r_t + \alpha_1 \lambda_1 r_t^e + \gamma \lambda_1 \left(\pi_t - \pi_t^e\right) + \lambda_1 \varepsilon_t - \alpha_1 \lambda_1 \alpha_0 + \alpha_1 \lambda_1 r_t^e + \alpha_1^2 \lambda_1 r_t^e = 0. \quad (15)$$

I take expectations at $t-1$ of (15), assuming that the expected value of ε_t is zero and the assumption of rational expectations. This gives

$$r_t^e = \frac{\lambda_1 \alpha_0 \left(1+\alpha_1\right)}{\lambda_0 + \lambda_1 \left(1+\alpha_1\right)^2}. \quad (16)$$

Combining (15) and (16) gives a structural decision rule for ALMP as a function of inflation, expected inflation, the supply shock and the parameters of the model:

$$r_t^c = \frac{\lambda_1 \alpha_0 \left(1+\alpha_1\right)}{\lambda_0 + \lambda_1 \left(1+\alpha_1\right)^2} - \frac{\lambda_1}{\lambda_0 + \lambda_1} \varepsilon_t - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} \left(\pi_t - \pi_t^e\right). \quad (17)$$

If (6) is substituted into (17), I can rewrite the decision rule for ALMPs in terms of demand and supply shocks and money growth as

$$r_t^c = \frac{\lambda_1 \alpha_0 \left(1+\alpha_1\right)}{\lambda_0 + \lambda_1 \left(1+\alpha_1\right)^2} - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} v_t - \frac{\lambda_1}{\lambda_0 + \lambda_1} \varepsilon_t - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} \left(m_t - m_t^e\right). \quad (18)$$

The first term is the expected size of ALMPs, which depends on the parameters of the model. The second and third term capture the stabilization of demand and supply shocks respectively. When the economy is hit by a positive demand shock, unanticipated inflation increases for a given m_t. This reduces open unemployment and thus the need for ALMPs. A positive supply shock increases employment and reduces open unemployment and the need for ALMPs. The fourth term shows that if actual money growth is higher than expected, it is optimal to reduce ALMPs, when actual money growth is higher than expected, there will be unexpected inflation. Then open unemployment decreases.

(5) and (14) together give:

$$\gamma \lambda_1 r_t + \gamma^2 \lambda_1 \left(\pi_t - \pi_t^e\right) + \gamma \lambda_1 \varepsilon_t + \pi_t - \gamma \lambda_1 r_t^e = 0. \quad (19)$$

To solve for expected money growth, I take expectations at $t-1$ of (19) and obtain

$$E_{t-1} \pi_t = 0.$$

Using (6), I can solve for expected money growth as

$$E_{t-1} \left(m_t + v_t\right) = 0.$$

Hence, expected money growth is equal to

$$m_t^e = E_{t-1} m_t = 0. \quad (20)$$

I can rewrite the first-order condition for money growth, (19), by inserting the expression for inflation, (6), and expected money growth equal to zero. Then, the structural decision rule for money growth can be written as

$$m_t = -v_t - \frac{\gamma\lambda_1}{1+\gamma^2\lambda_1}\varepsilon_t - \frac{\gamma\lambda_1}{1+\gamma^2\lambda_1}\left(r_t - r_t^e\right). \tag{21}$$

Optimal money growth is negatively dependent on demand shocks, supply shocks, and deviations from expected ALMP. The first term shows stabilization of demand shocks. A positive demand shock tends to increase inflation. Money growth is then reduced to fully offset the increase in inflation.

The second term represents stabilization of supply shocks. A positive supply shock increases employment and reduces open unemployment. The incentive to inflate is then weakened and money growth is lowered. Money growth only stabilizes supply shocks partially.

The third term captures the fact that if the actual size of ALMPs is higher than expected by the private sector, money growth is reduced. If actual ALMPs are higher than expected, open unemployment falls and weakens the incentive to create inflation.

Finally, I combine the structural rules for money growth and ALMP to solve for the *reduced forms* of the decision rules. First, I insert the decision rule for ALMPs, (18), the expected size of ALMPs, (16), and expected money growth equal to zero into the decision rule for money growth, (21). After some simplifications, I obtain the reduced form for money growth

$$m_t^c = -v_t - \frac{\gamma\lambda_1\lambda_0}{\gamma^2\lambda_1\lambda_0 + \lambda_0 + \lambda_1}\varepsilon_t. \tag{22}$$

When the government can commit policy, expected money growth cannot reduce unemployment, since it cannot create any inflationary surprises. In the absence of shocks, money growth is thus zero. The first term in (22) shows that money growth entirely stabilizes demand shocks. Since there is no goal conflict between inflation and open unemployment. When demand shocks are stabilized by money growth so that inflation is held at the target rate, open unemployment is also stabilized. The second term in (22) shows that supply shocks are partially stabilized by variations in money growth.

Inflation is then

$$\pi_t^c = -\frac{\gamma\lambda_1\lambda_0}{\gamma^2\lambda_1\lambda_0 + \lambda_0 + \lambda_1}\varepsilon_t.$$

Expected inflation is equal to the "target rate" of zero. Any inflation in this equilibrium is unexpected and occurs when the government exploits its informational advantage in order to stabilize shocks.

I substitute the structural rule for money growth, (21), and expected money growth equal to zero into the decision rule for ALMPs, (18) in a similar way. Then, I simplify by inserting the expected size of ALMPs, (16), which gives the reduced form of ALMPs as

$$r_t^c = \frac{\lambda_1 \alpha_0 (1+\alpha_1)}{\lambda_0 + \lambda_1 (1+\alpha_1)^2} - \frac{\lambda_1}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{23}$$

The first term is the expected size of ALMPs, and the second term is the effect of supply shocks on ALMPs. A positive supply shock increases employment and reduces open unemployment. Therefore, there is less need for ALMPs and their size is reduced. The reduction is only a fraction of the shock however, so that there is only partial stabilization of supply shocks. ALMPs do not stabilize demand shocks, since they are fully stabilized by money growth.

In practice, there might be corner solutions with $r_t = 0$, in case of large positive supply shocks or large positive demand shocks, since large shocks decrease open unemployment and may therefore entirely eliminate the need for ALMPs. To simplify, I shall only look at interior solutions. I must then impose restrictions on the distribution of the shocks ruling out large positive supply and demand shocks. This ensures that $r_t > 0$ is always valid.[2]

Open unemployment is

$$u_t^c = \frac{\alpha_0 \lambda_0}{\lambda_0 + \lambda_1 (1+\alpha_1)^2} - \frac{\lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t.$$

It is thus negatively dependent on supply shocks, but unaffected by demand shocks (because monetary policy fully stabilizes the latter).

Regular employment is

$$n_t^c = \frac{\left(\lambda_0 + \lambda_1 (1+\alpha_1)^2\right) - \lambda_1 \alpha_0 (1+\alpha_1) - \alpha_0 \lambda_0}{\lambda_0 + \lambda_1 (1+\alpha_1)^2} + \frac{\lambda_1 + \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t.$$

Accordingly, labor market and monetary policies are used to stabilize supply shocks. Altogether, there is only partial stabilization of supply shocks, since both open unemployment and employment are affected by supply shocks.

Finally, I evaluate the one-period expected loss under commitment as

$$V^c = E_{t-1}(L) = \frac{1}{2} \left[\frac{\alpha_0^2 \lambda_1 \lambda_0}{\lambda_0 + \lambda_1 (1+\alpha_1)^2} + \frac{\lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \sigma_\varepsilon^2 \right].$$

[2] More specifically, the restriction on the shocks is $(\varepsilon_t + \gamma v_t) < \frac{\alpha_0(\lambda_0+\lambda_1)}{(\lambda_0+\lambda_1(1+\alpha_1))}$. The condition is from section 3.1, which gives the most restrictive condition for the cases studied here. The condition ensures that ALMPs are always positive in these cases. The condition also ensures that open unemployment is always positive.

2.2 Discretion

Next, consider the more realistic discretionary case. The government cannot commit to the policy rules. Instead, *ex post* it can be optimal for the government to deviate from the announced rules in order to reduce open unemployment. The timing under discretion is thus: (**i**) the private sector determines wages and employment without knowing either the realization of the supply and demand shocks, or the size of ALMPs and the rate of money growth, i.e., they must form expectations of r_t^e and m_t^e. (**ii**) The values of v_t and ε_t are observed by the government; (**iii**) money growth and ALMPs are decided and implemented simultaneously after the formation of private-sector expectations and (**iv**) macroeconomic outcomes are realized.

The equilibrium is a Nash equilibrium, i.e., the government's choice of policy is the best response to the private-sector's choice of wages, and the private-sector's choice is the best response to the government's choice.

The government's minimization problem under discretion is

$$\begin{aligned} & \min_{r_t, m_t} L, \\ s.t\ u_t &= \alpha_0 - r_t - \alpha_1 r_t^e - \gamma\left(\pi_t - \pi_t^e\right) - \varepsilon_t, \\ \pi_t &= m_t + v_t. \end{aligned}$$

The difference from commitment is that the government does not internalize the effects of its policy on private-sector expectations. Instead, r_t^e and m_t^e are treated as given.

The problem of minimizing the loss function can be written as

$$\min_{r_t, m_t} \left\{ \frac{1}{2} \left(\lambda_0 {r_t}^2 + \lambda_1 {u_t}^2 + \pi_t^2 \right) \right\}.$$

The first-order conditions with respect to r_t is

$$\lambda_0 r_t - \lambda_1 u_t = 0. \tag{24}$$

The first-order condition for m_t is

$$-\gamma \lambda_1 u_t + \pi_t = 0. \tag{25}$$

In (24), the marginal benefit (loss) of a decrease (increase) in open unemployment due to an increase in r_t^e does not enter the first-order condition as in (11). The marginal cost of an increase in open unemployment when m_t^e increases does not enter (25) as in (14).

If I combine (24) and (5) this gives the first-order condition as

$$\lambda_0 r_t - \lambda_1 \alpha_0 + \lambda_1 r_t + \alpha_1 \lambda_1 r_t^e + \gamma \lambda_1 \left(\pi_t - \pi_t^e\right) + \lambda_1 \varepsilon_t = 0. \tag{26}$$

Next, I take expectations of (26) at $t-1$. This gives the expected size of ALMP as

$$r_t^e = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)}. \tag{27}$$

Then I combine (26) and (27), which gives the structural decision rule for ALMP under discretion as

$$r_t^d = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\lambda_1}{\lambda_0 + \lambda_1} \varepsilon_t - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} (\pi_t - \pi_t^e). \tag{28}$$

The decision rule can also be written in terms of money growth by substituting (6) into (28), i.e.

$$r_t^d = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\lambda_1}{\lambda_0 + \lambda_1} \varepsilon_t - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} v_t - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} (m_t - m_t^e). \tag{29}$$

As under commitment the optimal size of ALMPs under discretion thus depends negatively on supply shocks, demand shocks, deviations from expected money growth and on a constant. The second, third and fourth terms are the same as under commitment. The only difference is the first term, i.e. the expected (average) size of ALMPs.

Next, I solve for the decision rule for money growth. I begin with substituting the expression for open unemployment, (5), into the first-order condition for money growth, (25), which gives

$$-\gamma \lambda_1 \alpha_0 + \gamma \lambda_1 r_t + \gamma \lambda_1 \alpha_1 r_t^e + \gamma^2 \lambda_1 (\pi_t - \pi_t^e) + \gamma \lambda_1 \varepsilon_t + \pi_t = 0. \tag{30}$$

To solve for expected money growth, I take expectations of (30) at $t-1$. The first-order condition then simplifies to

$$E_{t-1} \pi_t = \gamma \lambda_1 \alpha_0 - (\gamma \lambda_1 \alpha_1 + \gamma \lambda_1) E_{t-1} r_t. \tag{31}$$

I can solve for expected money growth by inserting the expression for inflation, (6), into (31). Hence, expected money growth can be written as

$$m_t^e = E_{t-1} m_t = \gamma \lambda_1 \alpha_0 - (\gamma \lambda_1 \alpha_1 + \gamma \lambda_1) r_t^e. \tag{32}$$

To solve for the structural decision rule for money growth, I combine (6), (8), (30) and (32). Then I obtain the structural rule as

$$\begin{aligned} m_t^d &= \gamma \lambda_1 \alpha_0 - v_t - \frac{\gamma \lambda_1}{1 + \gamma^2 \lambda_1} \varepsilon_t \\ &\quad - \frac{\gamma \lambda_1}{1 + \gamma^2 \lambda_1} (r_t - r_t^e) - \gamma \lambda_1 (1 + \alpha_1) r_t^e. \end{aligned} \tag{33}$$

The second, third and fourth terms are the same as under commitment. The first and the fifth terms are different. The differences arise because the government decides on money growth, without considering the effect on private-sector expectations. The first term is a positive constant, i.e., a positive bias in money growth. The fifth term shows that the expected size of ALMPs now also affects money growth. When the expected size of ALMPs increases, open unemployment falls in both the crowding-in and crowding-out case (because of the assumption of $\alpha_1 > -1$ in the latter case). The incentive to inflate in order to reduce open unemployment is thus weakened and money growth is decreased. The intuition behind the other terms is the same as under commitment.

The reduced form rules of money growth and ALMP are found by combining the structural decision rules for ALMP and money growth. First, I combine (27), (29), (32) and (33). After some simplifications, the reduced form of money growth can be written as

$$m_t^d = \frac{\alpha_0 \gamma \lambda_1 \lambda_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - v_t - \frac{\gamma \lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{34}$$

The difference from commitment is found in the first term, i.e. expected money growth, where expected money growth is no longer equal to zero. This is due to the fact that the government has an incentive to increase money growth in order to create surprise inflation to reduce open unemployment. The second term shows that money growth still fully stabilizes demand shocks. It is always optimal to fully stabilize demand shocks to keep inflation at the target. The third term captures the partial stabilization of supply shocks through monetary policy, which is the same as under commitment.

Inflation under discretion becomes

$$\pi_t^d = \frac{\alpha_0 \gamma \lambda_1 \lambda_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\gamma \lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{35}$$

The expected inflation rate, i.e., the first term in (35), is no longer zero. The inflation bias is always positive but its size is affected by whether there are crowding-out or crowding-in effects of ALMP, i.e.,

$$E\left(\pi_t^d\right) - E\left(\pi_t^c\right) = \frac{\alpha_0 \gamma \lambda_1 \lambda_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} > 0.$$

Money growth fully stabilizes demand shocks and inflation is unaffected by demand shocks. The second term in (35) shows that variations in inflation partially stabilize supply shocks.

Finally, the reduced form of ALMP is derived by combining (27), (29), (32) and (34).

This gives the decision rule as

$$r_t^d = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\lambda_1}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{36}$$

The first term is the expected size of ALMPs and the second term represents the partial stabilization of supply shocks. The difference from commitment is found in the first term. The bias in the expected size of ALMP depends on the sign of α_1;

$$E\left(r_t^d\right) - E\left(r_t^c\right) = -\frac{\alpha_1 \lambda_1 \alpha_0 \lambda_0}{\left(\lambda_0 + \lambda_1 (1 + \alpha_1)\right)\left(\lambda_0 + \lambda_1 (1 + \alpha_1)^2\right)}.$$

(**i**) For crowding-out effects, the size of ALMPs is larger under discretion, i.e., there is a positive bias, due to the fact that the government no longer internalizes the effect of its policy on private-sector expectations.

(**ii**) For crowding-in effects, there is a negative bias in ALMP and the government sets the size of ALMPs at a too low level under discretion, since ALMPs create a positive externality on employment, but the government does not internalize this effect.

It is optimal to stabilize supply shocks with ALMPs to the same extent as under commitment. This result is independent of whether there are crowding-in or crowding-out effects of ALMPs.

Under discretion, open unemployment is

$$u_t^d = \frac{\alpha_0 \lambda_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{37}$$

The first term is expected open unemployment and the second term is the effect of supply shocks on open unemployment. The difference from commitment is the first term;

$$E\left(u_t^d\right) - E\left(u_t^c\right) = \frac{\alpha_0 \lambda_1 \lambda_0 \alpha_1 (1 + \alpha_1)}{\left(\lambda_0 + \lambda_1 (1 + \alpha_1)^2\right)\left(\lambda_0 + \lambda_1 (1 + \alpha_1)\right)}.$$

(**i**) For crowding-out effects, open unemployment is lower under discretion than under commitment. ALMPs have two effects on open unemployment. The first direct effect reduces open unemployment, since the size of ALMPs is larger under discretion than under commitment. Second, ALMPs reduce regular employment and increase open unemployment. However, the total effect is a decrease in open unemployment, since the crowding-out effect is less than one-to-one.

(**ii**) For crowding-in effects, open unemployment is higher under discretion than under commitment. First, open unemployment directly decreases with the size of ALMP. Second, ALMPs increase regular employment and decrease open unemployment. The two effects then work in the same direction, i.e., to increase open unemployment, since the size of ALMPs is lower under discretion than under commitment.

Regular employment is

$$n_t^d = \frac{(\lambda_0 + \lambda_1 (1+\alpha_1)) - \lambda_1 \alpha_0 - \alpha_0 \lambda_0}{\lambda_0 + \lambda_1 (1+\alpha_1)} + \frac{(\lambda_1 + \lambda_0)}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t.$$

The first term is expected employment. The second term, which shows the effect of supply shocks, is the same as under commitment. Expected employment is always lower under discretion;

$$E\left(n_t^d\right) - E\left(n_t^c\right) = -\frac{\alpha_0 \lambda_0 \lambda_1 \alpha_1^2}{(\lambda_0 + \lambda_1 (1+\alpha_1))\left(\lambda_0 + \lambda_1 (1+\alpha_1)^2\right)} < 0.$$

(**i**) For crowding-out effects, ALMPs reduce regular employment. Since ALMPs are larger under discretion than under commitment, employment is then smaller. The effect of the larger size of ALMPs under discretion is accordingly a reduction in open unemployment, but at a cost of lower regular employment.

(**ii**) For crowding-in effects, ALMPs increase regular employment. Under discretion, the size of ALMPs is lower than under commitment and therefore employment is lower under discretion.

The expected loss under discretion is

$$V^d = E_{t-1}(L) = \frac{1}{2}\left[\frac{\alpha_0^2 \lambda_1 \lambda_0 \left(\lambda_0 + \lambda_1 + \gamma^2 \lambda_1 \lambda_0\right)}{(\lambda_0 + \lambda_1 (1+\alpha_1))^2} + \frac{\lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1} \sigma_\varepsilon^2\right].$$

The expected social loss is always larger under discretion than under commitment, i.e;

$$V^d - V^c = \frac{1}{2} \alpha_0^2 \lambda_1^2 \lambda_0^2 \left(\frac{\alpha_1^2 + \gamma^2 \lambda_0 + \gamma^2 \lambda_1 (1+\alpha_1)^2}{\left(\lambda_0 + \lambda_1 (1+\alpha_1)^2\right)(\lambda_0 + \lambda_1 (1+\alpha_1))^2}\right) > 0.$$

In the sections above, I analyzed the time inconsistency problem of monetary policy and active labor market policy. In the two following sections, I shall study commitment to simple rules and delegation of policies to independent agencies as means of improving the discretionary outcome in section 2.2.

3 Commitment to simple rules

The government would achieve higher utility if the time inconsistency problems for labor market policy and monetary policy under discretion could be eliminated. If it were possible to credibly commit both monetary policy and labor market policy in the way discussed in section 2.1, the situation would clearly improve. This might not be possible however. Instead, the government may only be able to commit to very simple rules, and the question is then if the discretionary outcome can be improved upon in this way.

In the case of monetary policy, such a simple rule might be to join the EMU. This could be interpreted as a given rate of money growth decided by the European Central Bank, ECB, which does not adjust to domestic shocks.

In the case of ALMPs, a country could choose to abstain from setting up the institutional framework required for such programs (in terms of both labor-market training and job-creation measures). Sweden with its National Labor Market Board (AMS) at the country level to organize labor market policy is a country with an extensive active labor market policy. At the regional level, there are employment offices performing placement services to improve the matching process and providing different training schemes and job creation measures for the unemployed. The U.S which has very little active labor market policy and weak institutions for this might be a polar case.

3.1 Commitment to a simple money growth rule or entering the EMU

This section analyzes commitment to a simple rule of money growth. A possible interpretation of such commitment is participation in the monetary union, where the ECB decides monetary policy. The consequence is that the only stabilization tool in case of domestic shocks is then labor market policy.

The timing of the events is as follows: (**i**) the government announces a credible rule for money growth (enters the EMU); (**ii**) private agents form expectations of r_t^e and m_t^e; (**ii**) the values of v_t and ε_t are observed by the government; (**iv**) ALMPs are decided and implemented and (**v**) macroeconomic outcomes are realized.

Assume that the government can commit money growth to zero in each period. Inflation is then

$$\pi_t = v_t. \tag{38}$$

The government decides on the size of ALMPs in a discretionary way. Thus, the problem is to decide the size of ALMPs such that the actual loss is minimized, subject to the open unemployment equation (5), and the inflation equation (38).

The first-order condition for r_t is equal to (26). To solve for the expected size of ALMPs, I insert the equation for inflation, (38), into the first-order condition and take expectations at $t-1$. This results in (27), i.e., the expected size of ALMP when both monetary policy and ALMP are determined in a discretionary way. After some simplifications, the expression for ALMPs becomes

$$\widehat{r}_t = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\gamma \lambda_1}{\lambda_0 + \lambda_1} v_t - \frac{\lambda_1}{\lambda_0 + \lambda_1} \varepsilon_t. \tag{39}$$

Open unemployment becomes

$$\widehat{u}_t = \frac{\alpha_0 \lambda_0}{\lambda_0 + \lambda_1 (1 + \alpha_1)} - \frac{\gamma \lambda_0}{\lambda_0 + \lambda_1} v_t - \frac{\lambda_0}{\lambda_0 + \lambda_1} \varepsilon_t. \tag{40}$$

The expected size of ALMPs and the expected rate of open unemployment are the same as when both ALMPs and monetary policy were determined in a discretionary way. The simple rule removes the average inflation bias, since money growth is fixed, but leaves the bias in ALMP unaffected.

The third term in (39) shows that ALMPs stabilize supply shocks more under the simple rule than when both monetary policy and ALMP were determined in a discretionary way, i.e., the coefficient before the supply shock, ε_t, is now larger. The explanation is that when money growth is fixed, ALMPs substitute for monetary policy in stabilization policy.

The third term in (40) is the effect of supply shocks on open unemployment. The coefficient in front of ε_t is larger under the simple rule than when policies were determined in a discretionary way. This means that open unemployment is more variable when money growth is fixed.

Since monetary policy can no longer be used in stabilization policy, demand shocks are then stabilized with ALMPs. This is shown by the second term in (39). Earlier, monetary policy fully stabilized demand shocks and they had no effect on open unemployment. But labor-market policy does not completely stabilize demand shocks in the case with monetary-policy commitment.

When there is only one instrument available to the government, the total stabilization of shocks in the economy is lower than when it can use two instruments. The reason is that with two instruments, the government can equalize the cost of stabilizing shocks at the margin.

The expected loss under a simple money growth rule is

$$\widehat{V} = E_{t-1}(L) = \frac{1}{2} \begin{pmatrix} \lambda_0 \left(\frac{\lambda_1^2 \alpha_0^2}{(\lambda_0 + \lambda_1 (1+\alpha_1))^2} + \frac{\gamma^2 \lambda_1^2}{(\lambda_0 + \lambda_1)^2} \sigma_v^2 + \frac{\lambda_1^2}{(\lambda_0 + \lambda_1)^2} \sigma_\varepsilon^2 \right) \\ + \lambda_1 \left(\frac{\alpha_0^2 \lambda_0^2}{(\lambda_0 + \lambda_1 (1+\alpha_1))^2} + \frac{\gamma^2 \lambda_0^2}{(\lambda_0 + \lambda_1)^2} \sigma_v^2 + \frac{\lambda_0^2}{(\lambda_0 + \lambda_1)^2} \sigma_\varepsilon^2 \right) + \sigma_v^2 \end{pmatrix}.$$

If the government achieves a lower expected loss from the simple rule than when both policies are determined in a discretionary way or not depends on parameters of the model, but also on the variance of the supply and demand shocks. Comparing the expected losses gives

$$V^d - \widehat{V} = \frac{1}{2}\left(\begin{array}{c} \left(\frac{\gamma^2\lambda_1^2\alpha_0^2\lambda_0^2}{(\lambda_0+\lambda_1(1+\alpha_1))^2}\right) - \frac{\gamma^2\lambda_1^2\lambda_0^2}{(\lambda_0\gamma^2\lambda_1+\lambda_0+\lambda_1)(\lambda_0+\lambda_1)}\sigma_\varepsilon^2 - \\ \left(\frac{\lambda_0\gamma^2\lambda_1+(\lambda_0+\lambda_1)}{(\lambda_0+\lambda_1)}\sigma_v^2\right) \end{array} \right). \tag{41}$$

The effects on utility work in different directions when there is commitment to zero money growth. There is a positive utility effect from eliminating the inflation bias, but there is a negative effect from less stabilization of shocks. Accordingly it is difficult to draw any conclusions from (41), since the first term is positive while the others are negative. I shall, however, evaluate the expected losses for specific values of the parameters in the model. The variance of the supply shock is taken from Lindblad's (1997) estimation of a similar specification and it is 0.0002. The variance of the demand (velocity) shock is calculated from data on inflation and money growth for Sweden from Findata's database Trust for the period $1979 - 1997$. The value I use is 0.0007. The parameter α_0 measures open unemployment under perfect expectations and in the absence of ALMPs and shocks. I use the values 0.05 and 0.1. Empirical studies find different results for the labor demand elasticity. Hammermesh (1996) concludes that the long-run constant-output labor demand elasticity probably lies in the interval $[0.15 - 0.75]$ and that the best guess is 0.3. But I allow for output to change as the cost of labor changes so I must add the scale effect to obtain the total labor-demand elasticity. The value I use is 0.8. Society's weights on open unemployment and inflation are picked arbitrarily. In Table 1, the average values of ALMPs, inflation and open unemployment under discretionary policy for both labor market and monetary policy are shown for these parameter values.[3] The first numerical example might have reflected Sweden in the 1970's and the second example might have been a hypothetical Sweden during the 1990's, if monetary policy had not been conducted by an inflation targeting central bank.

When monetary policy follows the simple rule and labor market policy is discretionary, the average values are the same as when both labor market and monetary policy are discretionary except for average inflation, which is zero.

As can be seen from Table 2, it is unclear whether commitment of monetary policy improves welfare. It depends on whether the benefit of eliminating the average inflation

[3] If I assume the supply shock to be rectangularly (or continuously uniformly) distributed on the interval $[-0.024, 0.024]$, this gives $E(\varepsilon_t) = 0$ and $\sigma_\varepsilon^2 \approx 0.0002$. If I also assume that the demand shock is continuously uniformly distributed on the interval $[-0.046, 0.046]$, this gives $E(v_t) = 0$ and $\sigma_v^2 \approx 0.0007$. Then $(\varepsilon_t + \gamma v_t)$ is continuously uniformly distributed with $E(\varepsilon_t + \gamma v_t) = 0$ and $var(\varepsilon_t + \gamma v_t) \approx 0.0006$ on the interval $[-0.042, 0.042]$. These intervals are consistent with interior solutions for ALMPs and open unemployment for my numerical examples.

Parameter values	Crowding-in or crowding-out		
	crowding-in; $\alpha_1 = 0.3$	crowding-out; $\alpha_1 = -0.1$	crowding-out; $\alpha_1 = -0.9$
$\alpha_0 = 0.05$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$	$r_t = 0.021$ $\pi_t = 0.028$ $u_t = 0.023$	$r_t = 0.025$ $\pi_t = 0.033$ $u_t = 0.028$	$r_t = 0.041$ $\pi_t = 0.055$ $u_t = 0.046$
$\alpha_0 = 0.1$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$	$r_t = 0.041$ $\pi_t = 0.056$ $u_t = 0.047$	$r_t = 0.049$ $\pi_t = 0.067$ $u_t = 0.056$	$r_t = 0.081$ $\pi_t = 0.11$ $u_t = 0.092$

Table 1: Average values of ALMPs, inflation and open unemployment when both policies are determined in a discretionary way.

bias outweighs the cost of less effective stabilization of shocks. As I increase the crowding-out effects of ALMPs, monetary policy commitment is more likely to be better, due to the fact that both the bias in ALMPs and inflation increases with the crowding-out effect, when both policies are discretionary.

Parameter values	Crowding-in or crowding-out		
	crowding-in; $\alpha_1 = 0.3$	crowding-out; $\alpha_1 = -0.1$	crowding-out; $\alpha_1 = -0.9$
$\alpha_0 = 0.05$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$ $\sigma_\varepsilon^2 = 0.0002$ $\sigma_v^2 = 0.0007$	Discretionary policies⇒ lower loss	Rule for m_t ⇒lower loss	Rule for m_t ⇒lower loss
$\alpha_0 = 0.1$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$ $\sigma_\varepsilon^2 = 0.0002$ $\sigma_v^2 = 0.0007$	Rule for m_t ⇒lower loss	Rule for m_t ⇒lower loss	Rule for m_t ⇒lower loss

Table 2: The lowest expected loss from a comparison of the outcome under a rule for monetary policy and discretionary labor market policy with discretionary policy for both policies.

If the variances of the demand and supply shock are increased ten times, then the expected loss is always less if both monetary and labor market policies are discretionary, i.e., monetary policy commitment is welfare decreasing.

If the constant money-growth rule is interpreted as membership in the EMU, it might be claimed that I have given this case an unfair treatment. When I assume that monetary policy does not stabilize any shocks in this case, I have implicitly assumed that all shocks are country specific. However, some shocks may be common for all countries in the EMU and are therefore stabilized by the common monetary policy. My results are thus more favorable for the EMU case than one might at first believe, as a commitment of monetary policy in several cases still turns out more favorably than the alternative.

3.2 A simple rule for ALMPs – no institutions for labor market policy

A credible commitment of active labor market policy could be to abstain from setting up an institutional framework for ALMPs. If a country has already invested in the required institutions, it is less costly to deviate from the announced size of ALMP. However, for a country like the US, which has not invested in such a framework, a commitment to zero program is credible, since the institutions for ALMPs would have to be set up if policymakers were to deviate.

The timing in this case is; (**i**) the government announces a credible rule for ALMPs, that is, no institutions for ALMPs are set up; (**ii**) private agents form expectations of r_t^e and m_t^e; (**iii**) the values of v_t and ε_t are observed by the government; (**iv**) money growth is decided; and (**v**) macroeconomic outcomes are realized.

In this case, open unemployment is

$$u_t = \alpha_0 - \gamma\left(\pi_t - \pi_t^e\right) - \varepsilon_t. \tag{42}$$

The government determines money growth in a discretionary way, as in section 2.2. Thus, the problem is to decide on money growth such that the actual loss is minimized, subject to the inflation equation (6), and the open unemployment equation (42). The first-order condition for money growth is equal to (25) which is the first-order condition under discretionary policy for both money growth and ALMPs. If I insert open unemployment, (42), and the expression for inflation, (6), into the first-order condition for money growth, I obtain

$$-\gamma\lambda_1\alpha_0 + \gamma^2\lambda_1\left(m_t + v_t - m_t^e\right) + \gamma\lambda_1\varepsilon_t + m_t + v_t = 0. \tag{43}$$

To solve for expected money growth, I take expectations of (43) at $t-1$. This gives

$$\widetilde{m}_t^e = \gamma\lambda_1\alpha_0. \tag{44}$$

Next, I substitute (44) into (43). The rule for money growth becomes

$$\widetilde{m}_t = \gamma\lambda_1\alpha_0 - \frac{\gamma\lambda_1}{1+\gamma^2\lambda_1}\varepsilon_t - v_t. \tag{45}$$

This gives inflation as

$$\widetilde{\pi}_t = \gamma\lambda_1\alpha_0 - \frac{\gamma\lambda_1}{1+\gamma^2\lambda_1}\varepsilon_t, \tag{46}$$

and open unemployment becomes

$$\widetilde{u}_t = \alpha_0 - \frac{1}{1+\gamma^2\lambda_1}\varepsilon_t. \tag{47}$$

Expected open unemployment, the first term in (47), increases compared to the case with discretionary policy for both ALMPs and money growth, since

$$E(\tilde{u}_t) - E\left(u_t^d\right) = \frac{\alpha_0\lambda_1(1+\alpha_1)}{\lambda_0+\lambda_1(1+\alpha_1)} > 0.$$

For crowding-in effects, discretionary policy implies too low a size of ALMPs and too high open unemployment. Thus a commitment of ALMPs to zero is even worse, since this results in even higher open unemployment. For crowding-out effects, the size of ALMPs is too large under discretionary policy, but open unemployment decreases since the crowding-out effect is less than one to one. A commitment of ALMPs to zero thus increases open unemployment.

The government's incentive to create surprise inflation in order to reduce open unemployment after wage contracts have been concluded is thus strengthened. Expected inflation under commitment to zero ALMPs is then higher than when both policies were set in a discretionary way. More specifically,

$$E(\tilde{\pi}_t) - E\left(\pi_t^d\right) = \frac{\gamma\lambda_1^2\alpha_0(1+\alpha_1)}{\lambda_0+\lambda_1(1+\alpha_1)} > 0.$$

The ability to commit ALMPs means that the entire stabilization of demand and supply shocks takes place through monetary policy and, thus, through variations in inflation. The coefficient before ε_t in (46) is larger compared to the case when both policies were set in a discretionary way, i.e., the response of inflation to supply shocks is increased.

The second term in (47) is the effect of a supply shock on open unemployment. The coefficient is now larger than in the discretionary case. This means that the effect of supply shocks on open unemployment increases, since monetary policy is then the only instrument available; monetary policy and labor market policy can no longer be used so that the costs are equalized at the margin.

Demand shocks are still completely stabilized with money growth.

The expected loss, in a case with no institutions for ALMPs, is

$$\tilde{V} = \frac{1}{2}\left[\lambda_1\alpha_0^2 + \gamma^2\lambda_1^2\alpha_0^2 + \frac{\lambda_1}{1+\gamma^2\lambda_1}\sigma_\varepsilon^2\right].$$

To investigate if the government can achieve a lower expected loss if there are no institutions for labor market policy, I compare the expected losses under the simple rule and under discretionary policy:

$$\begin{aligned} V^d - \tilde{V} &= -\frac{\lambda_1^2}{2(1+\gamma^2\lambda_1)(\gamma^2\lambda_1\lambda_0+\lambda_0+\lambda_1)}\sigma_\varepsilon^2 - \frac{\alpha_0^2\lambda_1^3(1+\alpha_1)^2}{2(\lambda_0+\lambda_1(1+\alpha_1))^2} \\ &\quad - \frac{\gamma^2\alpha_0^2\lambda_1^3}{2}\frac{[(1+\alpha_1)(2\lambda_0+\lambda_1(1+\alpha_1))]}{(\lambda_0+\lambda_1(1+\alpha_1))^2} - \frac{\alpha_0^2\lambda_1^2\lambda_0(1+2\alpha_1)}{2(\lambda_0+\lambda_1(1+\alpha_1))^2}. \end{aligned} \tag{48}$$

(**i**) For crowding-in effects, $V^d - \widetilde{V} < 0$ is always valid, i.e. government welfare is always higher when both monetary and labor market policies are discretionary. There are three reasons for this: (*i*) When ALMPs have positive effects on employment, discretion means too small ALMPs. But if ALMPs are committed to zero as under the simple rule, this means an even lower size of ALMPs. (*ii*) Because zero ALMPs means higher unemployment than under discretion, inflation is increased. (*iii*) Shocks in the economy are stabilized to a smaller extent when ALMPs are committed to zero.

(**ii**) For crowding-out effects, the sign of $V^d - \widetilde{V}$ is ambiguous, since the first three terms in (48) are negative, but the fourth term may be positive. However, for crowding-out effects in the interval $-\frac{1}{2} < \alpha_1 < 0$, then $V^d - \widetilde{V} < 0$ is always valid, as this guarantees that the fourth term is negative. Then the expected loss is smaller under discretionary policy for both ALMPs and money growth than under commitment to zero for ALMPs. The reason is that for low crowding-out effects, the positive bias in ALMPs is low as is the gain from committing ALMPs to zero. Then, the cost of less stabilization of shocks and higher inflation outweighs the benefit of removing the bias in ALMPs.

(**iii**) If the crowding-out effects are in the interval $-\frac{1}{2} < \alpha_1 < 0$, then the fourth term is positive, and it is possible that $V^d - \widetilde{V} > 0$. For large crowding-out effects, there is a large positive bias in ALMPs. It may then be the case that the benefit of eliminating the positive bias in ALMPs outweighs the loss of relinquishing ALMPs as a stabilization policy and the cost of higher inflation.

It can be shown that plausible parameter values might result in a welfare gain from commitment of ALMPs to zero. This will for instance, occur if I set $\alpha_0 = 0.1$, $\lambda_0 = 1.7$, $\lambda_1 = 1.5$, $\gamma = 0.8$, $\alpha_1 = -0.9$ and $\sigma_\varepsilon^2 = 0.0002$. These values give an average inflation of 0.12 and an average open unemployment of 0.1.

4 Delegation of monetary and labor market policy to independent agencies

A well-known solution to the time inconsistency problem of monetary policy is that monetary policy decisions should be delegated to an independent conservative central bank, which can resist the political pressure to create inflation (Rogoff, 1985). This approach assumes delegation of policy to a bank with the same loss function as the government, but with a lower weight on unemployment. This reduces the average inflation bias, but, at the same time, also the degree of stabilization of shocks. Another proposed solution is to delegate monetary policy to a central bank which has the same loss function as the government, but which also takes into account that it will suffer an extra cost for creating inflation, according to a so-called optimal linear contract with the government. The optimal-linear contract removes the average inflation bias without any cost in terms of less stabilization and solves the commitment problem (Walsh, 1995; Persson and Tabellini, 1993). A third approach to the commitment problem of monetary policy is an inflation-targeting regime (Svensson, 1997). This can be interpreted as the delegation of monetary policy to a central bank with a different inflation target than the government. This can also eliminate the average inflation bias, without affecting the stabilization of shocks.

It might thus seem as if the optimal-contract and inflation-target approaches were the obvious ways of solving the time-inconsistency problem of monetary policy and that similar approaches solve the time-inconsistency problem of labor market policy.[4] There are also serious objections however. For instance, the optimal-contract approach just assumes that the contract can always be enforced. But if the government can assign a contract to the central bank, it can also revise the contract before monetary policy is determined. If there are costs of revising the conditions of the contract or the contract itself, delegation *reduces* the inflation bias, but the bias will not be eliminated unless the costs are prohibitive. Thus, if the decision on delegation is discretionary, the credibility problem of monetary policy is only mitigated (Jensen, 1997).

The inflation-target approach can be interpreted in two ways. One interpretation is that under an inflation-target regime, the government assigns a loss function with a specific inflation target to the central bank. The problem is then that the central bank is assumed to act according to the assigned loss function, even though no incentive mechanism has been designed. The other interpretation is that the government identifies a central banker with certain preferences, so that the appointed central banker achieves the desired outcome for inflation. But identifying a central banker with a lower inflation goal than the government but with the same relative weight on deviations from the inflation goal, would seem to require more information than might reasonably be assumed. One might possibly identify central bankers who are more inflation-adverse than the government, but how does one distinguish between the intercept (the inflation goal) and the slope coefficient (the relative weight) ?

[4] For instance, it is easy to show that if linear contracts are added to the loss functions of the labor market board and the central bank, the bias in ALMPs and inflation is removed. The loss for the central bank is $L^{cb} = \frac{1}{2}\left(\lambda_0 {r_t}^2 + \lambda_1 {u_t}^2 + \pi_t^2\right) + km_t$ and for the board $L^a = \frac{1}{2}\left(\lambda_0 {r_t}^2 + \lambda_1 {u_t}^2 + \pi_t^2\right) + hr_t$. If the constants are set equal to $h = \lambda_1\alpha_0 - \frac{\lambda_1\alpha_0(1+\alpha_1)(\lambda_0+\lambda_1+\alpha_1\lambda_1)}{\left(\lambda_0+\lambda_1+(1+\alpha_1)^2\right)}$ and $k = \gamma\lambda_1\alpha_0\frac{\lambda_0}{\left(\lambda_0+\lambda_1+(1+\alpha_1)^2\right)}$, both biases are removed.

I shall follow the "Rogoff" approach of letting the government delegate the conduct of active labor market policy and monetary policy to independent agencies, with the same loss functions as society, but, possibly, with different weights on open unemployment. The reason for my choice is that the cost associated with firing the heads of the central bank and the labor market board is likely to be greater than the cost of revising contracts and goals, which will make the problem of discretion with respect to delegation of policies less serious. Moreover, it might only be possible to determine if an individual cares more or less about open unemployment relative to the specific goals for inflation and ALMPs. This approach is also consistent with my model, in the sense that I have not allowed for different goals for inflation and ALMPs (the goals are just set to zero).

I will be studying the following examples. First, monetary policy is delegated to an independent central bank, whereas labor market policy is still conducted by the government. Second, I will let labor market policy, but not monetary policy, be delegated to an independent national labor market board. Finally, I will study simultaneous delegation of both monetary policy and labor market policy to independent agencies.

4.1 Independent central bank and discretionary labor market policy

At the beginning of the period, monetary policy is delegated to an independent central bank. The central bank's weight is λ_1^{cb} and society's weight is λ_1.

The timing is thus; (**i**) the institutional framework is decided, i.e., a decision is taken about the central banker to whom monetary policy should appropriately be delegated; (**ii**) private-sector agents form expectations of r_t^e and m_t^e; (**iii**) the values of v_t and ε_t are observed by the policymakers; (**iv**) money growth and ALMPs are decided simultaneously by the central bank and the government; and (**v**) macroeconomic outcomes are realized.

The appointment is thus the choice of the weight λ_1^{cb}. The private sector observes λ_1^{cb} and forms its expectations accordingly. After being appointed, the central banker determines the monetary policy in a discretionary way at stage (**iv**), according to his preferences. The problem can thus be solved like the problem in section 2.2, except for the weight on open unemployment which now is the central banker's weight. Then the decision of the optimal weight is the choice of a weight minimizing the society's expected loss. Thus, the problem is solved "backwards". First, the optimal policy given the central banker's weight is derived and then, the optimal weight minimizing the expected loss.

The problem for the central bank is to decide on money growth such that the actual loss is minimized. This amounts to the same first-order condition for money growth as under discretion except that the weight on open unemployment is now the central bank's weight instead of society's. This will give the same structural decision rule for money growth as under discretionary policies, (33), except that λ_1 is now replaced by λ_1^{cb}.

The government decides on ALMPs in a discretionary way. This gives a first-order condition for r_t equal to (24). The structural decision rule for ALMPs is equal to (29), i.e., the same rule as under discretionary policy for money growth and ALMPs. Then. I combine the structural rules and solve for the reduced form of the rules. For ALMPs, I get

$$r_t^{gov} = \frac{\lambda_1 \alpha_0}{\lambda_0 + \lambda_1 + \lambda_1 \alpha_1} - \frac{\lambda_1}{\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t, \tag{49}$$

which is expressed both in terms of the central bank's and society's weight on open unemployment. To find the rule for money growth, I insert the rule for ALMPs into the central bank's structural rule for money growth and simplify. I then obtain

$$m_t^{cb} = \frac{\alpha_0 \gamma \lambda_1^{cb} \lambda_0}{\lambda_0 + \lambda_1 + \lambda_1 \alpha_1} - v_t - \frac{\gamma \lambda_1^{cb} \lambda_0}{\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{50}$$

Inflation becomes

$$\pi_t^{cb} = \frac{\alpha_0 \gamma \lambda_1^{cb} \lambda_0}{\lambda_0 + \lambda_1 + \lambda_1 \alpha_1} - \frac{\gamma \lambda_1^{cb} \lambda_0}{\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1} \varepsilon_t. \tag{51}$$

To find the optimal weight on open unemployment for the independent central bank, I evaluate the expected loss, since monetary policy is delegated before the shocks are realized. The decision rules (49) and (50) are evaluated in the society's loss function. The expected loss is then

$$V = \frac{1}{2} \left[\frac{\alpha_0^2 \lambda_0 \left(\lambda_1^2 + \lambda_1 \lambda_0 + \gamma^2 \left(\lambda_1^{cb} \right)^2 \lambda_0 \right)}{\left(\lambda_0 + \lambda_1 + \lambda_1 \alpha_1 \right)^2} + \frac{\left(\lambda_0 \lambda_1^2 + \lambda_0^2 \lambda_1 + \gamma^2 \left(\lambda_1^{cb} \right)^2 \lambda_0^2 \right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1 \right)^2} \sigma_\varepsilon^2 \right].$$

I then take the derivative with respect to the central bank's weight on open unemployment and set this equal to zero

$$\frac{dV}{d\lambda_1^{cb}} = \frac{\alpha_0^2 \lambda_0^2 \gamma^2 \lambda_1^{cb}}{\left(\lambda_0 + \lambda_1 + \lambda_1 \alpha_1 \right)^2} + \frac{\gamma^2 \lambda_0^3 \left(\lambda_1^{cb} - \lambda_1 \right) + \gamma^2 \lambda_0^2 \lambda_1 \left(\lambda_1^{cb} - \lambda_1 \right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1 \right)^3} \sigma_\varepsilon^2 = 0. \tag{52}$$

Equation (52) is a fourth-order equation in λ_1^{cb}, which is difficult to solve. Therefore, I evaluate the derivative at the points $\lambda_1^{cb} = 0$ and $\lambda_1^{cb} > \lambda_1$. The first term is zero when

$\lambda_1^{cb} = 0$, and the second term is negative. Hence, the derivative is negative. For $\lambda_1^{cb} > \lambda_1$, the derivative is positive. The optimal weight is then in the interval $0 < \lambda_1^{cb} < \lambda_1$. This gives the familiar result that a conservative central banker with a lower weight on open unemployment than society, should be appointed. This result is valid for crowding-out effects as well as for crowding-in effects of ALMPs.[5]

A lower weight on open unemployment implies that average inflation decreases, i.e., that the first term in (51) decreases. Monetary policy stabilizes supply shocks less when λ_1^{cb} decreases; this is the second term in (51). The first term in (49) is the average size of ALMPs, which is unaffected by the central bank's weight on open unemployment. ALMPs stabilize supply shocks more when the central bank's weight on open unemployment decreases, since the coefficient for ε_t in (49) decreases in λ_1^{cb}. The central bank fully stabilizes demand shocks, since there is no goal conflict between inflation and open unemployment for the central bank either.

4.2 Independent labor market board and discretionary monetary policy

The next example shows delegation of labor market policy to an independent labor market board, with the same loss function as society, but with the weight λ_1^a on open unemployment.

The timing is thus; (**i**) the institutional framework is decided, i.e., a decision is taken to whom ALMPs should be delegated; (**ii**) private-sector agents form expectations of r_t^e and m_t^e; (**iii**) the values of v_t and ε_t are observed by the policymakers; (**iv**) ALMPs and money growth are chosen simultaneously by the labor market board and the government; and (**v**) macroeconomic outcomes are realized.

The problem is solved in a similar way as when monetary policy is delegated, that is, backwards.

The independent labor market board determines ALMPs in a discretionary way. The minimization problem is the same as under discretionary policy for both ALMPs and money growth. Hence, the first-order condition is equal to (24) except that λ_1 is replaced by λ_1^a. Thus, the structural decision rule for the labor market board is equal to (29), except for the weight. The government determines monetary policy with society's weight on open unemployment in the loss function. The first-order condition for money growth

[5] The second-order sufficient condition for a minimum is fulfilled, that is, the derivative $d^2V \,/\, d\left(\lambda_1^{cb}\right)^2$, is positive for $0 < \lambda_1^{cb} < \lambda_1$.

is equal to (25). Thus, the structural decision rule for money growth is equal to (33). I solve for the reduced form decision rules, by combining the government's rule for money growth and the labor market board's rule for ALMPs. This gives the rule for ALMPs as

$$r_t^a = \frac{\lambda_1^a \alpha_0}{\lambda_0 + \lambda_1^a (1+\alpha_1)} - \frac{\lambda_1^a}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a} \varepsilon_t. \tag{53}$$

The reduced form rule for money growth becomes

$$m_t^{gov} = \frac{\gamma \lambda_1 \lambda_0 \alpha_0}{\lambda_0 + \lambda_1^a (1+\alpha_1)} - v_t - \frac{\gamma \lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a} \varepsilon_t.$$

This gives inflation as

$$\pi_t^{gov} = \frac{\gamma \lambda_1 \lambda_0 \alpha_0}{\lambda_0 + \lambda_1^a (1+\alpha_1)} - \frac{\gamma \lambda_1 \lambda_0}{\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a} \varepsilon_t. \tag{54}$$

To find the optimal weight for the labor market board, I evaluate the expected social loss when ALMPs are determined by an independent labor market board and money growth is determined by the government. The expected social loss is

$$V = \frac{1}{2} \left[\frac{\alpha_0^2 \lambda_0 \left((\lambda_1^a)^2 + \lambda_1 \lambda_0 + \gamma^2 \lambda_1^2 \lambda_0 \right)}{\left(\lambda_0 + \lambda_1^a (1+\alpha_1)\right)^2} + \frac{\lambda_0 \left((\lambda_1^a)^2 + \lambda_1 \lambda_0 + \gamma^2 \lambda_1^2 \lambda_0 \right)}{\left(\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a\right)^2} \sigma_\varepsilon^2 \right].$$

The first-order condition with respect to λ_1^a is

$$\begin{aligned} \frac{dV}{d\lambda_1^a} &= \frac{\alpha_0^2 \lambda_0^2 (\lambda_1^a - \lambda_1)}{\left(\lambda_0 + \lambda_1^a (1+\alpha_1)\right)^3} - \frac{\alpha_0^2 \lambda_0^2 \lambda_1 \left(\alpha_1 + \gamma^2 \lambda_1 (1+\alpha_1)\right)}{\left(\lambda_0 + \lambda_1^a (1+\alpha_1)\right)^3} \\ &\quad + \frac{\lambda_0^2 (\lambda_1^a - \lambda_1)}{\left(\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 + \frac{\gamma^2 \lambda_1 \lambda_0^2 (\lambda_1^a - \lambda_1)}{\left(\gamma^2 \lambda_1 \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 = 0. \end{aligned} \tag{55}$$

Like equation (52), this derivative is a fourth-order equation in λ_1^a, which it is difficult to solve. Instead, I once more evaluate the derivative at extreme values for the weight. But, it is then generally difficult to analytically verify that the second-order derivative is positive in the relevant interval or at the optimal value of λ_1^a. However, I still analyze the derivative at the extreme values, to understand what the possible solutions are.

At $\lambda_1^a = 0$, the derivative reduces to

$$\frac{dV}{d\lambda_1^a} = -\frac{\lambda_1 \alpha_0^2 (1+\alpha_1)}{\lambda_0} - \frac{\alpha_0^2 \gamma^2 \lambda_1^2 (1+\alpha_1)}{\lambda_0} - \frac{\lambda_1 \lambda_0^2}{\left(\gamma^2 \lambda_1 \lambda_0 + \lambda_0\right)^3} \sigma_\varepsilon^2 - \frac{\gamma^2 \lambda_1^2 \lambda_0^2}{\left(\gamma^2 \lambda_1 \lambda_0 + \lambda_0\right)^3} \sigma_\varepsilon^2 < 0.$$

For crowding-in effects, (55) is negative when $\lambda_1^a < \lambda_1$. For $\lambda_1^a > \lambda_1$, the second term is negative, while the other terms are positive. Thus, if there is a solution, must to be at a value of $\lambda_1^a > \lambda_1$, since the derivative might then change signs and become positive.

Therefore, the optimal appointment may be to a liberal labor market board. The intuition for this is that the time inconsistency problem for both inflation and ALMPs are reduced, since the size of ALMPs are too low for crowding-in effects under discretion compared to under commitment. When λ_1^a increases, the average size of ALMPs (the first term in (53)) increases and open unemployment decreases. This reduces the incentive to inflate, i.e., the first term in (54) decreases.

For crowding-out effects, the optimal delegation may be either to a conservative or to a liberal central bank. When $\lambda_1^a < \lambda_1$, the sign of the derivative (55) is ambiguous, since the second term may be positive, while the other terms are negative. A condition for the second term to be negative is that $\alpha_1 + \gamma^2\lambda_1 (1 + \alpha_1) > 0$. This means that the crowding-out effect fulfills

$$\alpha_1 > -\frac{\gamma^2\lambda_1}{\gamma^2\lambda_1 + 1}. \tag{56}$$

Then, the social loss is reduced if labor market policy is delegated to a liberal labor market board. The intuition for appointing a liberal labor market board, despite the fact that the time inconsistency problem for ALMPs deteriorates, is that an increase in the size of average ALMP reduces open unemployment. The temptation to inflate the economy then decreases, as it is positively related to the rate of open unemployment.

If inequality (56) is not satisfied, then the second term is positive when $\lambda_1^a < \lambda_1$. If the second term dominates the other terms, the derivative, (55), can be positive when $\lambda_1^a < \lambda_1$. Then, the optimal weight for the labor market board is less than the society's weight. A lower λ_1^a reduces the first term in (53), but increases the first term in (54). For large crowding-out effects when the bias in ALMPs is large, the benefit of a reduction in the bias in ALMPs may be larger than the cost of the increase in the inflation bias.

I shall use the numerical values from section 3.1 to exemplify the above statements. The solution to the fourth-order equation is such that there are two imaginary solutions and two real solutions. One real solution is positive and one is negative. Since I have restricted the weights to be positive, the positive real root is the solution. In Table 3, the results (the positive real root) from the numerical exercise are shown and the second-order derivative is positive at these optimal values.

The results show that one might get a liberal labor market board even when ALMPs have crowding-out effects on employment. The average values of ALMPs, inflation and open unemployment, when labor market policy is delegated and monetary policy is discretionary, are shown in Table 4.

There is a trade off between reducing the biases and stabilization, since a change

Parameter values	Crowding-in or crowding-out			
	$\alpha_1 = 0.3$	$\alpha_1 = -0.1$	$\alpha_1 = -0.4$	$\alpha_1 = -0.9$
$\alpha_0 = 0.05$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1^a = 3.51$ **liberal**	$\lambda_1^a = 2.59$ **liberal**	$\lambda_1^a = 1.76$ **liberal**	$\lambda_1^a = 0.32$ **conserv.**
$\alpha_0 = 0.1$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1^a = 3.75$ **liberal**	$\lambda_1^a = 2.63$ **liberal**	$\lambda_1^a = 1.76$ **liberal**	$\lambda_1^a = 0.30$ **conserv.**

Table 3: The degree of open unemployment aversion for the labor market board when labor market policy is delegated and monetary policy is discretionary

Parameter values	Crowding-in or crowding-out			
	$\alpha_1 = 0.3$	$\alpha_1 = -0.1$	$\alpha_1 = -0.4$	$\alpha_1 = -0.9$
$\alpha_0 = 0.05$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$	$r_t = 0.028$ $\pi_t = 0.016$ $u_t = 0.014$	$r_t = 0.032$ $\pi_t = 0.025$ $u_t = 0.021$	$r_t = 0.032$ $\pi_t = 0.037$ $u_t = 0.031$	$r_t = 0.0091$ $\pi_t = 0.059$ $u_t = 0.049$
$\alpha_0 = 0.1$ $\lambda_0 = 1.7$ $\lambda_1 = 1.5$ $\gamma = 0.8$	$r_t = 0.057$ $\pi_t = 0.031$ $u_t = 0.026$	$r_t = 0.065$ $\pi_t = 0.05$ $u_t = 0.042$	$r_t = 0.064$ $\pi_t = 0.074$ $u_t = 0.062$	$r_t = 0.017$ $\pi_t = 0.118$ $u_t = 0.098$

Table 4: Average ALMPs, inflation and open unemployment when labor market policy is delegated and monetary policy is discretionary

in the weight on open unemployment alters the stabilization of shocks. For instance, a conservative labor market board stabilizes supply shock less with ALMPs and inflation then tends to stabilize supply shocks more, in comparison with a liberal labor market board.

4.3 Independent central bank and labor market board

Finally, I analyze simultaneous delegation of monetary policy and labor market policy to independent agencies. I assume that the central bank determines money growth and the labor market board determines ALMP. The weight on open unemployment for the central bank is λ_1^{cb} and for the labor market board, λ_1^a.

The timing is thus; (**i**) the institutional framework is decided, i.e., delegation of monetary policy and labor market policy; (**ii**) private-sector agents form expectations of r_t^e and m_t^e; (**iii**) the values of v_t and ε_t are observed by the policymakers; (**iv**) money growth and ALMP are chosen simultaneously by the central bank and the labor market board; and (**v**) macroeconomic outcomes are realized.

The minimization problem for the central bank is equal to the minimization problem for the independent central bank in section 4.1. The structural rule for money growth is therefore identical to the structural rule under discretion, (33), except that the weight is now the central banker's weight. Moreover, the minimization problem for the labor market board is equal to the problem for the independent board in section 4.2. This gives the structural decision rule equal to (29), except that λ_1 is replaced with λ_1^a. The reduced form rules are solved for by combining the structural rules for the central bank and the labor market board. This gives the decision rule for ALMPs as

$$r_t^a = \frac{\lambda_1^a \alpha_0}{\lambda_0 + \lambda_1^a (1+\alpha_1)} - \frac{\lambda_1^a}{\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a} \varepsilon_t. \tag{57}$$

The reduced form rule of money growth becomes

$$m_t^{cb} = \frac{\gamma \lambda_1^{cb} \lambda_0 \alpha_0}{\lambda_0 + \lambda_1^a (1+\alpha_1)} - v_t - \frac{\gamma \lambda_1^{cb} \lambda_0}{\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a} \varepsilon_t. \tag{58}$$

Next, I evaluate the social expected loss with society's weights on open unemployment, but with the decision rules for the independent labor market board and central bank. The expected social loss is

$$V = \frac{1}{2} \left[\frac{\alpha_0^2 \left(\lambda_0 (\lambda_1^a)^2 + \lambda_1 \lambda_0^2 + \gamma^2 \left(\lambda_1^{cb}\right)^2 \lambda_0^2 \right)}{(\lambda_0 + \lambda_1^a (1+\alpha_1))^2} + \frac{\left(\lambda_0 (\lambda_1^a)^2 + \lambda_1 \lambda_0^2 + \gamma^2 \left(\lambda_1^{cb}\right)^2 \lambda_0^2 \right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a\right)^2} \sigma_\varepsilon^2 \right].$$

To find the optimal weight for the independent labor market board, I take the derivative with respect to λ_1^a. This simplifies to

$$\begin{aligned} \frac{dV}{d\lambda_1^a} = {} & \frac{\alpha_0^2 \lambda_0^2 (\lambda_1^a - \lambda_1)}{(\lambda_0 + \lambda_1^a (1+\alpha_1))^3} - \frac{\alpha_0^2 \lambda_0^2 \alpha_1 \lambda_1}{(\lambda_0 + \lambda_1^a (1+\alpha_1))^3} - \frac{\alpha_0^2 \lambda_0^2 \gamma^2 \left(\lambda_1^{cb}\right)^2 (1+\alpha_1)}{(\lambda_0 + \lambda_1^a + \alpha_1 \lambda_1^a)^3} \\ & + \frac{\gamma^2 \lambda_0^2 \lambda_1^{cb} \left(\lambda_1^a - \lambda_1^{cb}\right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 + \frac{\lambda_0^2 (\lambda_1^a - \lambda_1)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 = 0. \end{aligned} \tag{59}$$

Again, the derivative is a fourth-order equation in λ_1^a, which it is difficult to solve analytically.

The optimal weight for the central bank is also a fourth-order equation, but in λ_1^{cb}

$$\frac{dV}{d\lambda_1^{cb}} = \frac{\alpha_0^2 \gamma^2 \lambda_1^{cb} \lambda_0^2}{(\lambda_0 + \lambda_1^a (1+\alpha_1))^2} + \frac{\gamma^2 \lambda_0^3 \left(\lambda_1^{cb} - \lambda_1\right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 + \frac{\lambda_0^2 \gamma^2 \lambda_1^a \left(\lambda_1^{cb} - \lambda_1^a\right)}{\left(\gamma^2 \lambda_1^{cb} \lambda_0 + \lambda_0 + \lambda_1^a\right)^3} \sigma_\varepsilon^2 = 0. \tag{60}$$

The solution to the two fourth-order equations should be such that both equations are fulfilled at the same time. It is difficult to draw any general conclusions from the two equations. I shall therefore evaluate the derivatives for my numerical examples. The solution to the two fourth-order equations are pairs of roots. Two pairs of roots involve real solutions and the relevant solution is the pair where both roots are positive. The second-order sufficient conditions for a minimum is fulfilled for the relevant solutions[6]. In Tables 5 and 6, it is shown that one can get different outcomes for delegation of monetary and labor market policy.

Parameter values			λ_1^a	λ_1^{cb}
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = 0.3$	1.91	0.15
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.1$	1.36	0.09
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.4$	0.93	0.067
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.9$	0.22	0.073

Table 5: Numerical examples of delegation of monetary policy and labor market policy

Parameter values			λ_1^a	λ_1^{cb}
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = 0.3$	1.94	0.044
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.1$	1.35	0.025
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.4$	0.91	0.018
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\sigma_\varepsilon^2 = 0.0002$	$\lambda_1 = 1.5$ $\alpha_1 = -0.9$	0.17	0.022

Table 6: Numerical examples of delegation of monetary policy and labor market policy

For crowding-in effects, the optimal delegation is a delegation to a liberal labor market board and a conservative central bank. The intuition is that the biases in both ALMPs and inflation are reduced when λ_1^a increases, i.e., the first term in (57) increases and the first term in (58) decreases. In addition, a lower λ_1^{cb} reduces the inflation bias further.

For small crowding-out effects, my earlier parameter values give that the optimal delegation is to a conservative labor market board and to a conservative central bank. However, if the weight on open unemployment is increased and the weight on ALMPs

[6] The second-order sufficient conditions are $d^2V/d\left(\lambda_1^{cb}\right)^2 > 0$, $d^2V/d\left(\lambda_1^a\right)^2 > 0$ and $\left(d^2V/d\left(\lambda_1^{cb}\right)^2\right)\left(d^2V/d\left(\lambda_1^a\right)^2\right) > \left(d^2V/d\lambda_1^{cb}\lambda_1^a\right)^2$

Parameter values			λ_1^a	λ_1^{cb}
$\alpha_0 = 0.05$	$\lambda_0 = 0.7$	$\lambda_1 = 2$	2.32	0.11
$\gamma = 0.8$	$\sigma_\varepsilon^2 = 0.0002$	$\alpha_1 = -0.1$		

Table 7: Delegation to a liberal LMB and a conservative CB

is decreased in the government's loss function, the delegation of labor market policy can then be made to a liberal labor market board and the delegation of monetary policy to a conservative central bank, see table 7 .

The intuition behind a conservative LMB is that the positive bias in ALMPs is increasing in λ_1^a and the inflation bias is decreasing in λ_1^a. Thus, a conservative board reduces the bias in ALMP, but increases the inflation bias. To reduce the inflation bias, the central bank's weight is lower than society's and the board's. As explained earlier, the intuition for a liberal board is that it reduces the inflation bias, even though the time inconsistency problem in ALMPs deteriorates.

For moderate and large crowding-out effects, the optimal delegation is to a conservative central bank and a conservative labor market board. The intuition behind a conservative LMB and a conservative CB is the same as above.

The trade-off between stabilization of shocks and reduction of the biases is also present when both monetary and labor market policy are delegated. But it is then difficult to determine how stabilization is affected when both labor-market policy and monetary policy are delegated, as compared to discretionary policy for both. For instance, when both policies are delegated to conservative agencies, the conservative board stabilizes supply shocks less with ALMPs, which tends to increase the stabilization of supply shocks with inflation. But at the same time, a conservative bank stabilizes supply shock less with inflation and this increases the stabilization with ALMPs compared to discretionary policy.

The average values of open unemployment, inflation and ALMPs, when both policies are delegated, are shown in Tables 8, 9 and 10.

The labor market board is always more liberal than the central bank and the central bank is always conservative. Even when looking at extreme cases, it is not possible to generate a liberal central bank, even though that case cannot be analytically ruled out. If the cost of inflation is very low relative to the cost of open unemployment and ALMPs in the governments loss function or/and if the variance of the supply shock is large, this would strenghten the case for a liberal central bank. For instance, even if the weight on inflation is 1,000,000 times smaller than the other weights, the bank does not become

Parameter values				$E(u_t)$	$E(\pi_t)$	$E(r_t)$
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = 0.3$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.15$	$\lambda_1^a = 1.91$	0.020	0.0024	0.023
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.1$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.087$	$\lambda_1^a = 1.36$	0.029	0.0021	0.023
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.4$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.067$	$\lambda_1^a = 0.93$	0.038	0.0020	0.021
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.9$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.073$	$\lambda_1^a = 0.22$	0.049	0.0029	0.0063

Table 8: Average values of open unemployment, inflation and ALMPs, when both monetary and labor market policy are delegated

Parameter values				$E(u_t)$	$E(\pi_t)$	$E(r_t)$
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = 0.3$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.044$	$\lambda_1^a = 1.94$	0.040	0.0014	0.046
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.1$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.025$	$\lambda_1^a = 1.36$	0.058	0.0012	0.046
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.4$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.018$	$\lambda_1^a = 0.91$	0.076	0.0011	0.041
$\alpha_0 = 0.1$ $\gamma = 0.8$	$\lambda_0 = 1.7$ $\alpha_1 = -0.9$	$\lambda_1 = 1.5$ $\lambda_1^{cb} = 0.022$	$\lambda_1^a = 0.17$	0.099	0.0017	0.0099

Table 9: Average values of open unemployment, inflation and ALMPs, when both monetary and labor market policy are delegated

liberal. When I increase the variance of the supply shock, the central bank gradually becomes less conservative but it never becomes liberal.

The intuition for this is that the inflation bias is decreasing in the labor market board's weight on open unemployment. This gives an incentive for choosing a less conservative LMB in order to reduce the inflation bias. At the same time, there is no interaction between the central bank's weight on open unemployment and the bias in ALMPs. This means that there is no incentive to make the central bank liberal, in order to reduce the bias in ALMPs. Furthermore, a liberal central bank means increased stabilization of supply shocks with inflation and less stabilization with ALMPs and if the cost of inflation is low compared to the cost of ALMPs, this could result in a liberal CB. This effect is

Parameter values				$E(u_t)$	$E(\pi_t)$	$E(r_t)$
$\alpha_0 = 0.05$ $\gamma = 0.8$	$\lambda_0 = 0.7$ $\alpha_1 = -0.1$	$\lambda_1 = 2$ $\lambda_1^{cb} = 0.11$	$\lambda_1^a = 2.32$	0.013	0.0011	0.042

Table 10: Average values of open unemployment, inflation and ALMPs when the labor market board is liberal and the central bank is conservative

obviously not strong enough to make the central bank liberal, however.

The simultaneous delegation of labor market and monetary policy can be summarized in Table 11:

	Delegation to:	
Effects of ALMP:	Labor Market Board	Central Bank
Crowding-in	liberal	conservative
Low crowding-out	liberal/conserv.	conservative
Moderate crowding-out	conservative	conservative
Large crowding-out	conservative	conservative

Table 11: Simultaneous delegation of labor market policy and monetary policy

5 Summary

Both active labor market policy and monetary policy suffer from a time-inconsistency problem. In models of time inconsistency problems for monetary policy, there is a positive inflation bias under discretion. The bias in ALMPs under discretion can either be positive or negative. If ALMPs increase wages and have a crowding-out effect on regular employment, the bias in ALMPs is positive. If ALMPs reduce wages and have a crowding-in effect on employment, the bias is negative.

A monetary-policy commitment to zero money growth eliminates the inflation bias. A country that has committed its monetary policy in this way, only uses labor market policy as a stabilization instrument. It stabilizes both supply and demand shocks less than a country using both monetary and labor market policy, since ALMPs and monetary policy are imperfect substitutes when it comes to stabilizing shocks. A monetary-policy commitment may thus improve the utility for the government, if the benefit from eliminating the inflation bias is larger than the cost of being less able to stabilize shocks.

A country with a labor market policy committed to zero has a higher expected inflation rate and higher expected open unemployment than a country using both monetary policy and labor market policy in a discretionary way. Thus, the commitment of labor market policy increases the time inconsistency problem for monetary policy.

If ALMPs have crowding-in effects and low or moderate crowding-out effects, the discretionary conduct of both labor market policy and monetary policy gives a lower expected loss compared to a situation with commitment of labor market policy. But for ALMPs with large crowding-out effects, the advantage of from eliminating a large positive bias in ALMPs, may outweigh the cost of higher inflation, higher open unemployment and less stabilization of shocks.

In models of monetary policy, delegating monetary policy to an independent conservative central bank is one way of improving the discretionary outcome. In Table 12, the results of delegation of monetary and labor market policy to independent agencies are summarized.

	Delegation of:		
Effect of ALMPs:	**Monetary policy**	**Labor market policy**	**Labor market and Monetary policy**
Crowding-in	*cons. CB*	*lib. LMB*	*lib. LMB* *cons. CB*
Low crowding-out	*cons. CB*	*lib. LMB*	*lib/cons. LMB* *cons. CB*
Moderate crowding-out	*cons. CB*	*lib/cons LMB*	*cons. LMB* *cons. CB*
Large crowding-out	*cons. CB*	*cons. LMB*	*cons. LMB* *cons. CB*

Table 12: Summary of delegation of monetary policy and labor market policy

Delegation of labor market policy when monetary policy is discretionary can be made either to a conservative or to a liberal labor market board. For ALMPs that have crowding-in effects, delegation to a liberal labor market board always improves the utility for the government. For ALMPs with low to moderate crowding-out effects, the optimal delegation is to a liberal labor market board, even though this deteriorates the time inconsistency problem for labor market policy, since it reduces the inflation bias. For ALMPs with large crowding-out effects, the delegation is made to a conservative labor market board, since the bias in ALMPs is then large and a conservative board reduces this bias. This effect weighs more heavily in this case than the increase of the inflation bias.

When labor market policy is discretionary, monetary policy is always delegated to a conservative central bank.

Delegation of both labor market policy and monetary policy gives similar results as when each policy is delegated independently. However, the labor market board is less likely to be liberal for ALMPs with crowding-out effects, since the conservative central bank then reduces the inflation bias and the incentive for choosing a liberal labor market board is weakened. The possibility of a liberal central banker cannot be ruled out analytically, but I have not succeeded in constructing numerical examples where this occurs. In all my examples, monetary policy is delegated to a conservative central banker and the central bank is also always more conservative than the labor market board.

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